DOCUMENT RESUME

ED 264 110 SE 046 270

TITLE	Plastics in Our Lives. What We Make. Science and Technology Education in Philippine Society.
INSTITUTION	Philippines Univ., Quezon City. Inst. for Science and Mathematics Education Development.
SPONS AGENCY	Educational Development Projects Implementing Task Force (Philippines).
REPORT NO	ISBN-971-135-085-8
PUB DATE	Jan 85
NOTE	27p.; For other documents in this series see SE 046 255-274.
AVAILABLE FROM	University of the Philippines, Institute for Science and Mathematics Education Development, Pardo de Tavera St., Diliman, Quezon City, Philippines ($2.85).
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Chemistry; Foreign Countries; High Schools; *Laboratory Procedures; *Plastics; Science Activities; Science Education; *Secondary School Science; Waste Disposal
IDENTIFIERS	*Philippines

ABSTRACT

This module, recommended for third or fourth year high school students, consists of three parts. The first part (entitled "Knowing Plastics") gives some background information regarding the origin of plastics, their chemical and physical properties, and the different available types. The second part (entitled "Shaping Plastics") describes how things are made from plastics. It includes lists of materials needed and procedures for laminating a diploma on wood and for making articles from plexiglass or acrylic plastic. The third part (entitled "Plastics and Health") discusses why the public is cautioned on the use of plastics for food containers. It also deals with how plastics add to the waste disposal problem. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

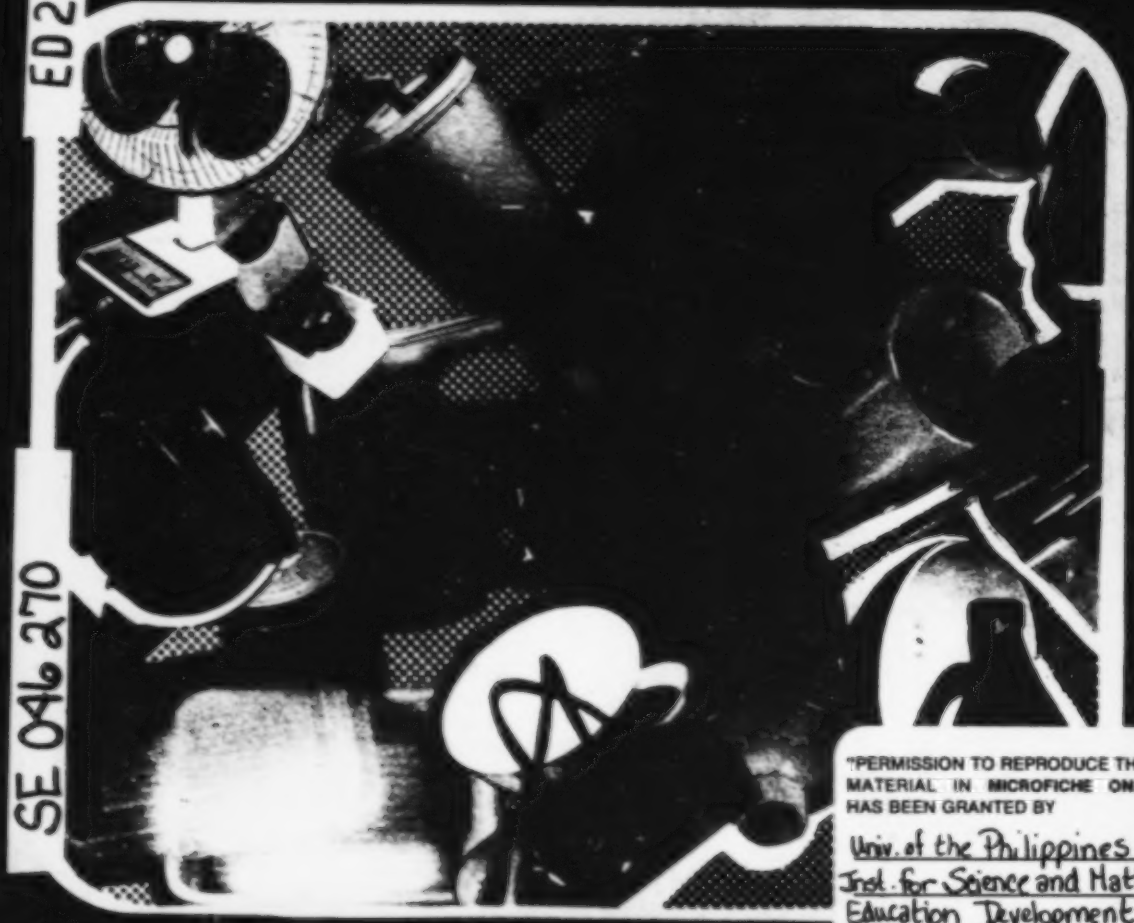
☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

What We Make

ED264110

SE 046 270



"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Univ. of the Philippines Inst. for Science and Math. Education Development

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Science and Technology Education in Philippine Society

8.17

Plastics in Our Lives

This is one of a series of science modules prepared by the University of the Philippines Institute for Science and Mathematics Education Development (ISMED) supported by the Educational Development Projects Implementing Task Force (EDPITAF).

Section 9, P.D. 49: "No copyright shall subsist in any work of the government of the Philippines. However, prior approval of the government agency or office wherein the work is created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose as a condition the payment of royalties."

ISBN 971-135-025-8
Published and printed by the

INSTITUTE FOR SCIENCE AND MATHEMATICS EDUCATION DEVELOPMENT
Vidal A. Tan Hall
University of the Philippines
Diliman, Quezon City

January, 1985

PLASTICS IN OUR LIVES

PROJECT TEAM

Recommended Level: 3rd or 4th year High School

Writer: Merle C. Tan

Consultant: Pilar da Silva

Reviewer: Dolores F. Hernandez

Project Coordinator: Vivien M. Talisayon

Project Assistant: Evelyn L. Josue

Editor: Risa L. Reyes

Illustrator: Cesar T. Palad

Publications Staff: Arthur V. Abaloyan
Benedicto A. Artugue
Ester A. Bautista
Camilo M. Encarnacion
Ruben L. Gabuat
Mario C. Gallardo
Regino L. Lamorena
Pedro A. Laurino
Renante M. Lunas
Erlando B. Mangaser
Filipinas M. Mendoza
Guillerma F. Plata
Cesar M. Sagun

ACKNOWLEDGMENTS

The technical assistance of the Chief of the Quality Control Division, Tupperware, Philippines is gratefully acknowledged.

The comments and suggestions of a group of Grade 10 students of the University of the Philippines Integrated School were also helpful in the revision of the module.

Thanks also goes to Mr. Ernie Bernabe of San Francisco del Monte for demonstrating the process of wood lamination.

INTRODUCTION

The time has come, the chemist said,
to talk of many things
Of poker chips, umbrella tips,
and combs and teething rings.
Of minnow traps and bottle caps
and toys and button-hooks,
Of banjo picks and magic tricks
of blotter tops, electric clocks,
The number is fantastic!
And all these things the chemist brings
Into the world with plastic.

By Edward Mabley

Plastics are everywhere. You see many kinds of plastic articles at home and in your friends' homes: bowls and buckets, cups and saucers, television cabinets, chairs, clothes pegs and toys, parts of refrigerators and washing machines, and many others. In many industries, builders use them for wall and floor coverings, light fittings, pipes, plumbing and insulation against cold. Similarly, in airplanes they are used on walls, seats, and food trays. The motorcar industry uses them for dashboards, steering wheels, car seats or interior fittings, and even for some engine parts. Plastic wrappers of many kinds are being used on a large scale in the packaging industry, and in small scale by the corner food vendors. In the textile industry, plastics are formed into fibers, such as nylon and terylene and made into cloth for clothes and furnishings. Another important use is in the manufacture of tough paints, varnishes, and adhesives. In medicine, they are used as implants in the human body, as replacements for hip sockets and corneas, or as cartilage substitutes in the nose or joints in the finger. Even in agriculture, plastics are useful not only as seedling cover, but as soil conditioners. A plastic product called *Kritium* is added to the soil to improve its texture particularly if it gets sticky when wet and heavy when dry.

You can add to this seemingly endless list of the uses of plastics but it is not enough to list them one after another. Knowedge about plastics should not end with such lists. It is also important to weigh these benefits against the complaints of pollution and dangers to health.

This module consists of 3 parts. "Knowing Plastics" gives some background information regarding the origin of plastics, their chemical and physical properties and the different available types. "Shaping Plastics" describes how things are made from plastics. It suggests some simple things you can do with them. "Plastics and Health" discusses why the public is cautioned on the use of plastics for food containers. It also deals with how plastics add to the waste disposal problem.

It is hoped that through this module you will develop a greater awareness of the world in which you live.

Plastics in Our Lives

KNOWING PLASTICS

WHERE PLASTICS COME FROM

When we think of plastics, we usually think of man-made materials or substances. Do you know that there are many plastic substances found in nature? Beautiful amber comes from trees, as does rosin. Lac is a substance made by an insect which we make into a commercial product called shellac. Rubber is another kind of natural plastic that comes from the rubber tree. Casein comes from milk.

Table 1. Some Naturally Occurring Plastics and Their Uses

Plastic Substances	Uses
Amber	as semi-precious stone used in jewelry
Rosin	used by violinists to rub their bows to prevent from slipping
Lac	as shellac used as protective coating for wooden furniture
Rubber	in tires of vehicles
Casein	made into buttons and hair decor

The raw material for most plastics now available are chemicals obtained from crude oil. They are made in chemical plants and are supplied to plastic article manufacturers in different forms. Some are in powder form, others are granular. Many supply them as a sticky liquid, sometimes as rods, tubings or sheets.

Besides the chemicals from crude oil, plastics contain small quantities of other substances often added to modify a plastic material and make it suitable

for a particular purpose. The range of properties can be modified by adding colored pigments or other substances that will make plastics . . .

. . . soft and flexible

. . . or hard so they can be worked as if they were wood or metal

. . . transparent or opaque

. . . and resistant to acids or other chemicals.

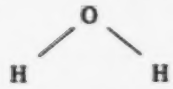
CHEMICAL PROPERTIES OF PLASTICS

Look at the variety of plastic articles. From what you see, it is difficult to describe what plastics really are. You will however understand the properties of plastics once you understand something about the way long chain compounds are made up, how they behave and why they behave as they do.

You know that all substances, gas, solid, or liquid, are made up of tiny particles called *molecules*. All the molecules in one substance are the same. For example, all water molecules are the same, and so are all sugar molecules. Similarly, all polyethylene (the most common plastic) molecules are the same, but the polyethylene molecules are different from the sugar and water molecules. All these molecules are so small that the largest can be seen only with a powerful magnifier.

Even though molecules are small, they are made up of even smaller particles called *atoms*. There are 106 different known atoms and they can be combined in different ways to give many different molecules; some arrangements are stable and give us compounds we know well. Some atoms are better at combining than others. Carbon is the most versatile, combining in many more ways to give us more compounds than any other atom. ALL PLASTICS ARE CARBON COMPOUNDS.

Some molecules are small with only few atoms. For example water, H_2O.



Other molecules, like proteins and carbohydrates, are very long. PLASTICS ALSO HAVE LONG CHAIN MOLECULES.

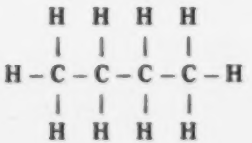
How are long chain molecules formed? It was mentioned that the most versatile and most frequently occurring atom is carbon. It is the basic atom in all organic materials and all materials which come from living organisms, including coal, oil and their by-products.

Carbon can exist by itself as soot, diamond and graphite, all of which are different forms of it, but mainly it links up with other atoms especially hydrogen (H), oxygen (O), nitrogen (N) and chlorine (Cl). Each atom has a certain number of links available for linking up with other atoms. For example,

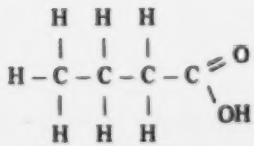
Carbon has 4 links
Hydrogen has 1 link
Oxygen has 2 links
Chlorine has 1 link

For our purpose, we can picture these links like arms, though in reality they are dependent on the structure of the atom.

Carbon can form a chain and the other atoms link up to it in different ways.

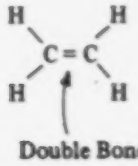


butane

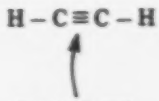


butyric acid

Sometimes the carbon forms a double bond using two of its four links to join with another carbon atom, leaving two spare bonds left for other atoms. Carbon can also form a triple bond.

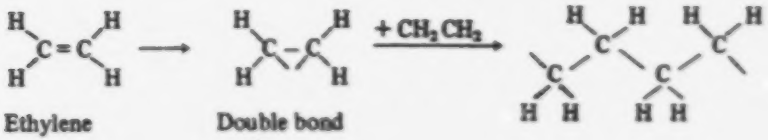


Double Bond



Triple Bond

Let us go back to the double bond. It is usually a weak point because it can split leaving one pair of arms linked while the other is free to link with something else as shown below.



Ethylene

Double bond split

If you have lots of ethylene molecules linking up together in this way you could have a large molecule of just carbon and hydrogen with no spare arms or double bonds where other atoms could be popped in and so it would be quite stable.

The product of joining "many ethylenes" is polyethylene, often shortened to polythene. The original molecule is called the monomer and the long chain is called *polymer*. Each polymer may have about 1000 to 50,000 of the monomers linked together.

$$n\ [CH_2CH_2] \longrightarrow [-CH_2CH_2-]n$$

n ethylene molecules — a portion of a polyethylene molecule

4

Several other plastics are formed in the same way. It is therefore easy to identify the origin of a particular kind of plastic by looking at the last part of the word.

vinyl chloride	⟶	polyvinyl chloride
styrene	⟶	polystyrene
propylene	⟶	polypropylene

The process of joining these molecules together is called *polymerization* (making polymers). This usually involves heating the monomer with a catalyst (to help the reaction along) and is normally done under pressure. This process varies with the different kinds of plastic.

The joining of small molecules "poly" times to form a long chain molecule is accompanied by changes in properties. Colorless liquids or gases for example, become foams, fibers or film.

PHYSICAL PROPERTIES OF PLASTICS

Plastics can be softened by heat and molded on cooling. What explains this property?

Like any chemical molecule, plastic molecules are in a state of motion. The molecular chains possess kinetic energy (energy of motion) and are vibrating and rotating and sliding over one another, rather like a lot of live catfish in a bucket.

When large molecules are heated, the molecules gain energy and move about vigorously. The chains become separated and the attractive forces are weakened. As a result, the large molecule becomes soft and flexible and on further heating turns into a viscous liquid. When the material is cooled, the molecular chains come close together again and attract one another more. The material solidifies and becomes stronger and stiffer.

TYPES OF PLASTICS ACCORDING TO PHYSICAL PROPERTIES

There are two basic types of plastic and the difference is quite marked.

Thermoplastics are shaped by heating until they can be molded and then allowed to cool to fix their shape. You can warm up thermoplastics again and mold them into something else and then cool them down again to set them in the new shape. The process can go on forever provided the thermoplastic material is not decomposed.

Candle wax behaves in this way too, becoming pliable and "plastic" when warmed but hardening when cooled down.

Thermosets, on the other hand have definite links between the chains formed when they are first heated, and once these links have been made they are there for good. Heat will not change the shape of a thermoset after it has set in the mold. Thermosets are therefore good at resisting heat. When you cook an egg it sets and the action of heat is to change it from the original in the shell. There is nothing you can do which will change your egg back – it has been "thermoset."

Old plastic articles like this may be melted and formed into a new article.

Thermoplastics soften at about 150°C.

Plastics not affected by heat higher than 150°C may be called *thermosets*.

TO SUM UP THE PROPERTIES

- Plastics are a group of substances which have some properties in common. They have, however widely varying characteristics which man can adjust depending on the needs of a particular situation. See Table 2.
- Plastics now available are man-made. There are a few natural ones like horn, amber and shellac but these are diminishing very fast.
- All plastics are carbon-based, they are organic compounds built up from carbon chains or rings.
- All plastics are polymers, that is, they are long chains of various lengths made by combining many of a simple unit (but not all polymers are plastic).
- All raw plastics can be molded by heat. After the first molding, thermoplastics can be resoftened and reset as often as is needed, but thermosets are set forever.

Table 2. Some Common Plastics and Their Uses

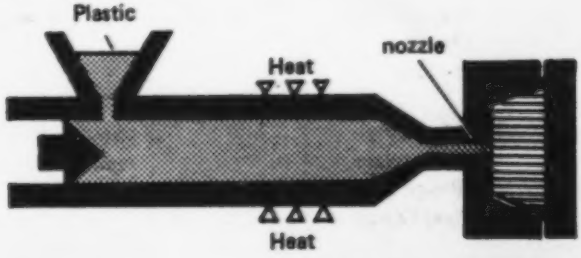
Plastics	Type	Common Uses
polyethylene	thermoplastic	bags, containers, water pipes, film and sheet
polypropylene	"	molded chairs, carpets, domestic ware that need sterilizing
polyvinyl chloride (PVC)	"	water piping, flexible laboratory tubing, upholstery covering, toys
polystyrene	"	packaging, plates, cups and trays; used as foam in insulated food containers
nylon	"	stockings, clothing, carpets
polytetrafluoro ethylene (teflon)	"	non-stick pans for cooking
polymethyl-metacrylate (Perspex or Plexi Glass)	"	contact lenses, false teeth, light covers; replaces many uses of glass
epoxy resin	thermoset	adhesives, construction of airplanes
urea formal-dehyde (UF)	"	plywood and chipboard manufacture
phenol formal-dehyde (PF)	"	electrical insulation
melanine for-maldehyde (MF)	"	laminex and formica, used for surfaces of wooden furniture, unbreakable cups and saucers, plates

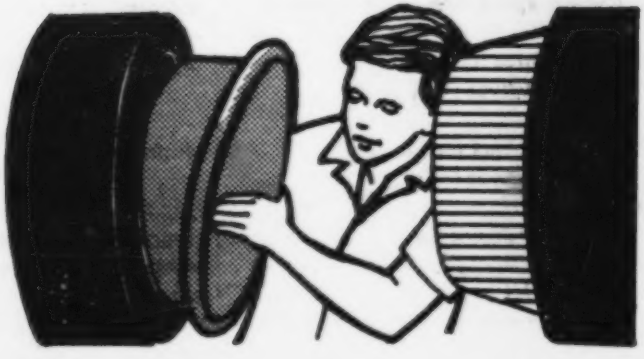
HOW THINGS ARE MADE FROM PLASTIC

Most plastics are made at present from chemicals obtained from crude oil. In the Philippines we do not make our own plastic. We import them from Japan or the United States and fabricate them into many types of articles. The 1983 data of the Bureau of Census and Statistics lists 300 registered plastic article manufacturers in Metro Manila alone.

There are different processes used to shape a variety of plastic articles. All the processes depend on the fact that the plastics being used can be softened by heat. Expensive machinery is used to press the plastic into the required shape, using a mold. The softened plastic will take up the shape of the mold, and when it is cool it can be removed.

The most common method is called *injection molding*, and it is exactly what the name says. The plastic material is heated first and then injected under pressure into a cold mold where it cools and hardens. The mold opens, releases the object and then repeats the cycle.

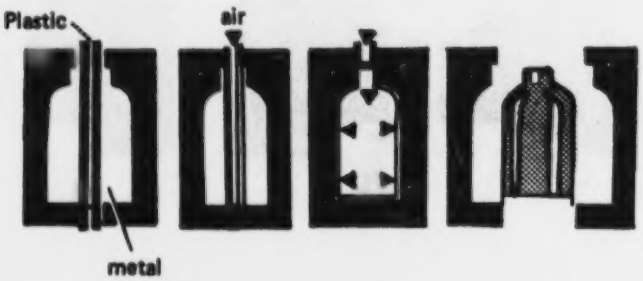




An article which has been made by this method comes off the production line with a small bump where it was cut off at the nozzle. This is cut level but the little bump is always there – usually in the center of the bottom of bowls and cups, ball-point pens and other articles.

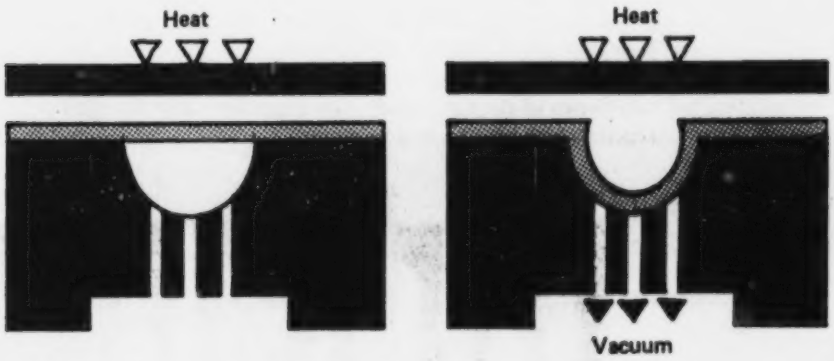
Another common method which is very suitable for bottles and containers (which we use in great numbers) is called *blow molding*. Again the name is descriptive of the process.

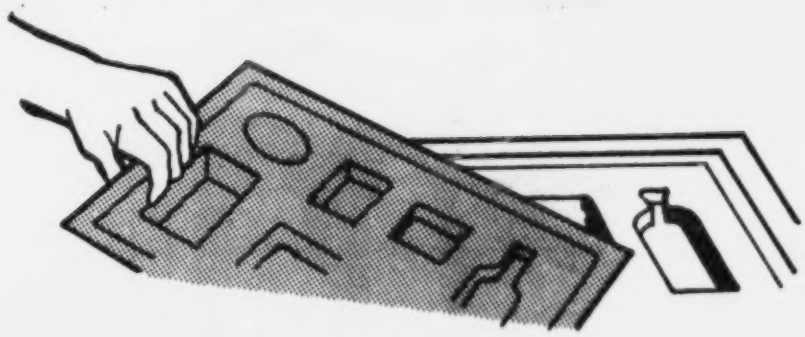
A length of softened plastic is inserted into the hollow cavity of a vertically split mold. The mold closes around the tube, sealing off one end. Air, under pressure, is blown in through the open end and the tube is blown up rather like a balloon. As it takes up the shape of the mold, it sets. The mold is opened to release the article. This method leaves a slight ridge around the article where the two halves of the mold meet. The ridges are easily felt. You can sort out plastic articles which have been blow molded.



The inside of chocolate boxes, the part which holds individual chocolates, is made by a different method – one which is ideal for making things containing depressions, such as refrigerator linings and egg-boxes. This method is called *vacuum forming* and makes use of sheet plastics.

A sheet of plastic material is clamped in a frame over a mold and warmed up until it becomes flexible. Then it is suddenly sucked down on to the mold where it cools, taking on whatever shape the mold possesses.

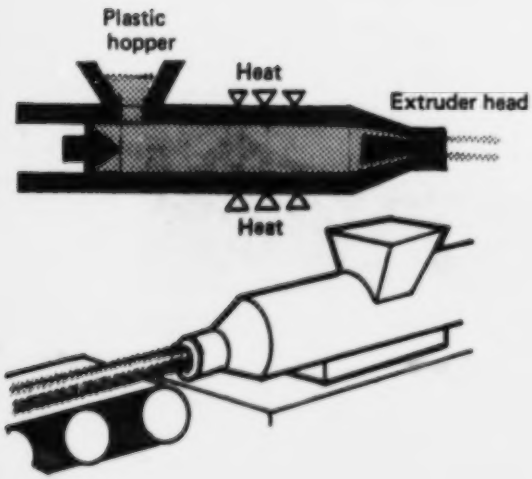




Extrusion is a method used for manufacturing any fibre or long length with uniform cross section such as pipes, curtain rails, films, and it is used to coat wires.

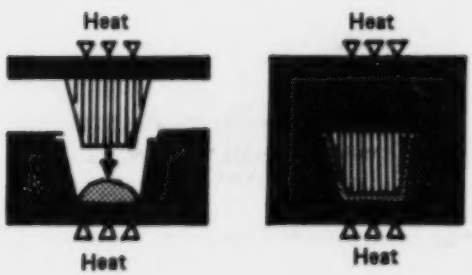
The hole on the end of the extrusion machine is changed – like the nozzle of an icing bag – to give a different-shaped strand.

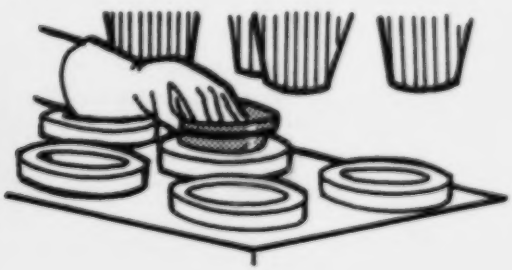
The machine works just like an old mincer with a screw inside to grind and push the meat through. The plastic manufacturer feeds in the plastic material and turns the screw, forcing the shaped plastic out of the end in long threads. These long threads assume the desired shape as they go through the nozzle. To give you an idea of how this works, think of an icing bag with a variety of nozzles that give you the kind of shape you want. In a similar way, plastic threads assume a particular shape depending on the design of the nozzle.



Extrusion for children

Compression molding is used for thermosetting plastics. A two-piece mold is heated with steam and the lower half is filled with pellets of the thermosetting molding powder. The pellets soften the upper half of the mold is compressed with the lower, and the powder is forced into the mold shape. Cross-linking occurs and the mold opens to eject the finished article.

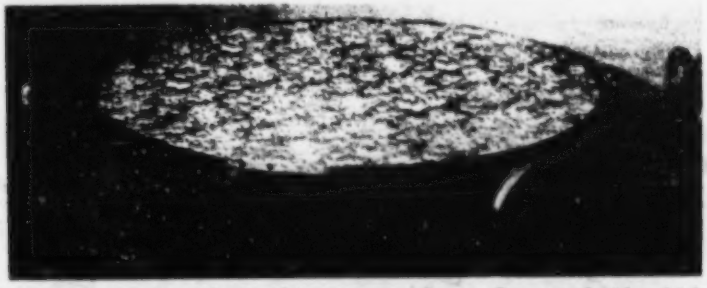




The strong plastic sheets used for surfaces such as kitchen and bathroom benches (e.g., formica) are made by a process called *lamination*. Laminated plastics are made by soaking several sheets of the basic material (usually paper or cloth) in a thermosetting plastic, then pressing the sheets together and hardening them in an oven.

Laminated plastics which use cloth are very strong. Because they do not corrode or rust, they are often used for gear, wheels and machinery axles.

Fiberglass car bodies and boat hulls are other examples of laminated plastics. Fiberglass consists of alternate layers of glass, cloth and plastic.



Look at the various plastic objects in your home. Can you decide which process was used to mold them by studying their shapes and surface marks?

The machinery required in plastic material fabrication may cost thousands of pesos, and the plastic articles compared, for example, with wood – are expensive. But so efficient are the machines at turning out precisely shaped articles at a very quick rate that articles made from plastics are usually cheaper to buy than similar articles made of other materials.

SOME THINGS YOU CAN DO

Have you wondered how diplomas or photographs are laminated on wood? You can do this easily. You can buy the lamination mixture in hardwares.

Materials:

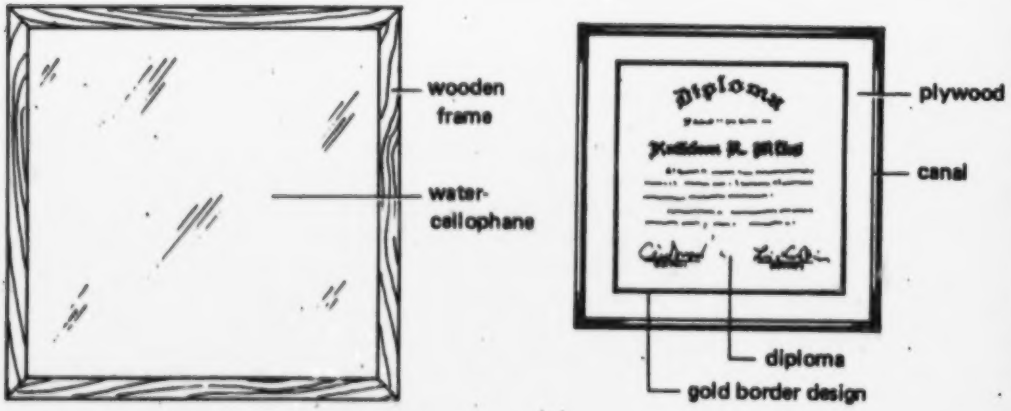
50 mL Polylite*
7 drops cobalt accelerator*
4 drops hardener*
water cellophane
red oxide enamel point
varnish
brush
masking tape
plywood frame (1 cm thick)**
wood – 1 cm wide for water cellophane frame**

*You can buy in hardwares in quart can, enough for 8 frames.
**Size will depend on the size of diploma or photograph.

Laminating Diploma on Wood

Preliminary Activities

1. Make a wood frame 5 cm bigger on all sides than the diploma or photograph you want to laminate. Paste watercellophane on the frame and see to it that the cellophane does not sag. Wipe the surface with wet cloth. If it sags, stretch the cellophane and paste in place on the wood-frame. You will use this later.
2. Make a plywood frame 2 cm bigger on all sides than the diploma. Varnish the plywood.
3. Put masking paper on the canal of the frame. This is where the excess mixture will drip.
4. Paste the diploma on the same size of cartolina and paste together on the plywood frame. If a photograph no need for the cartolina.
5. Put a gold border along the sides of the diploma. Apply natural nail polish on the gold border, signatures, names and dates to prevent blotting of the ink.



Lamination Procedures

1. Choose a warm sunny day to do wood lamination.
2. Take 50 mL of the polylite. Add 7 drops cobalt accelerator and 4 drops hardener.

BEST COPY AVAILABLE

3. Pour immediately at the center of the diploma and press with the framed watercellophane. Spread the polylite all over the surface of the plywood using a roller or round bottle.
4. Expose the laminated wood under the sun to dry and harden for about 2 hours. Remove the watercellophane.
5. Strip off the masking paper with a sharp blade. Sand paper the canal and apply red oxide again. Varnish and let dry.

Making Articles From Plexi Glass or Acrylic Plastic

Plexi glass is transparent and you can cut or saw or bore a hole on it as you would metal or wood. Utility boxes or flower vases can be made out of plexi glass. Here is how you do it.

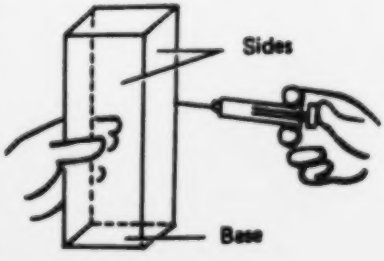
What you need

plexi glass from a hardware store (choose the correct thickness you need)
chloroform for connecting the plexi glass
a piece of capillary tube or syringe for dispensing chloroform

CAUTION: DO NOT INHALE CHLOROFORM. WORK IN THE OPEN.

What you do

1. Cut the plexi glass into sizes you desire. For example if you want to make a flower base, cut 4 long sides and a square base. See illustration.
2. Connect the plexi glass pieces by applying, little by little, chloroform on the edges. Press the edges hard for a while (about 10 sec) before releasing the pressure. Do this for all the sides.



A plastic vase

3. After attaching the sides, check for leaks by putting water into the vase you prepared. If there are leaks, mark the point where it leaks and apply chloroform again.

You can make other articles from plexi glass. Toy planes and models can be made from them.

BULLETIN TODAY, WED., MAR. 16, 1983

Public cautioned on plastics

Use as food containers needs approval

USING PLASTICS FOR FOOD CONTAINERS

Plastics are widely used for food containers and wrappers. The type of plastic containers in the country are:

polyethylene for—

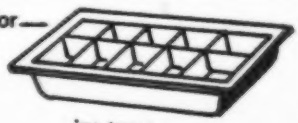
frozen meat

bottle caps

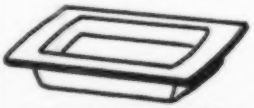
catsup

polypropylene for—

drinking cups



ice trays



margarine containers

water pitchers

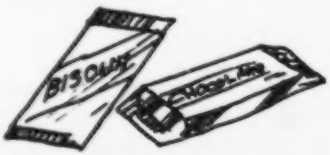
polystyrene for—

food bowls

ice cream containers

food containers in refrigerator

polyvinyl chloride (PVC) —



blister pop pack and containers for biscuits and chocolates

Plastics are used for food containers and wrappers because they are light, tough and transparent and have low permeability to water vapor. They are practically odorless and fatless. One of their advantages is that they are easy to seal by heat. However, they permit gases, such as oxygen and carbon dioxide, to pass through. They are therefore not suitable for packaging food which are subject to oxidation.

As was mentioned earlier, the addition of several compounds to plastics poses many uncertainties regarding the suitability for food purposes of plastic containers. One problem is that some particles from the plastic product may migrate or move into the food. This can occur because some plastic components are soluble in fats and oils. Also, decomposition of the components of the plastic material by heat may make insoluble components soluble. These are the reasons why the Bureau of Food and Drugs (BFD) cautions the public on the use of plastics for food containers.

To safeguard the health of the consumers, the BFD requires that manufacturers of plastic containers submit their products for analyses to determine whether levels of toxic additives in plastic materials are contained in safe amounts. The BFD conducts a "leachability test," a method which checks on the migration of particles from the plastics to the food.

SAFETY TIPS

The BFD is finalizing its report on the safety of locally manufactured plastic products as food containers. Meanwhile the consumers are advised to consider the following points:

1. Plastics must be regarded as single-use or one-way packages because return and reuse is impossible. No satisfactory method for cleaning is known so that even the re-use of emptied plastic containers in the household is limited by the fact that the plastic material tends to absorb fats and odorous components of foodstuffs and will retain the smell of the last commodity it contained. Besides, after repeated cleansings, the relatively soft surfaces of the plastic material become covered with scratches where bacteria may settle.

2. Polystyrenes must not be used in storing hot liquids or fatty foods because they have a low melting point.

3. Polyvinyl chlorides (PVC's) must be used only for dried food. PVC is inert and nontoxic. What is toxic is its simple molecule vinyl chloride. This is dangerous to the health of plastic plant workers as it is reported to cause chronic liver poisoning.

4. Large containers for intermediate storage of technical products may be reused for a certain time, as long as they are used for the same or a compatible product.

DISPOSING USED PLASTICS

Plastics are thoughtlessly discarded in roads and fields. They are eyesores. Dumped into the environment, they remain there and provide breeding grounds for disease-carrying insects and rats.

WHAT TO DO WITH PLASTICS WHEN WE'RE THROUGH WITH THEM

Plastics, like other solid wastes, may be disposed of in sanitary land fills. Sanitary land fills are usually vacant lots away from a water source. Authorities dig the ground where the wastes are compacted and dumped, then covered with layers of soil on top. Because plastics are not affected by rain or chemicals in the air and the soil and they do not decompose, they can make the ground firm.

The problem is that the volume of solid wastes is tremendous and the land available for use as "dumps" is rapidly decreasing with increasing population. Cities are looking for disposal areas far away.

Solid wastes may be burned. Most plastics will burn. This "solution" to the solid waste problem, however, leads to increased air pollution. For example, PVC produces toxic HCl when it burns. But some of the products of burning (such as benzene, styrene and acetylene) can be recycled as raw materials for other chemical processes.

A great deal of research is needed in the area of disposal of plastics. We need to know more about their burning products. We need to know how to control such burning to minimize air pollution. Plastics that are biodegradable (can be decomposed by microorganisms) or those that will disintegrate upon application of chemicals which use the sun's ultraviolet rays to help break down plastics within a given time should be developed. These solutions require more chemistry. The research involved will cost a good deal of money.

SOME QUESTIONS TO *THINK ABOUT*

Can We Do Away With Plastics?

Yes we can, but before we choose this easy solution, remember that the "flood of plastic objects" did not arise out of whim. Plastics slowly became necessary over a period of 30 to 40 years for the following reasons.

1. Natural resources dwindled and many materials became scarce.
2. With rising labor costs, many items could be made less expensive with molding than by any other method of manufacture.
3. The new materials were superior in properties that they did the job better.

Where Will Plastics Come From When the Earth's Supply of Petroleum is Exhausted?

The raw materials for man-made plastics are organic chemicals derived from petroleum. These are cheaper than the natural materials even though the price of oil has risen sharply since 1973. But petroleum is nonrenewable. It seems therefore that the long range future of plastic looks dismal unless we control our use of petroleum. Petroleum is the principal source of energy in the country. Not only are plastics and energy linked through the raw material-fossil fuel relationship, but large amounts of energy are required to purify starting materials and to change them into the desired plastics in the preferred shapes. It is the age old principle that we cannot continue to have our "cake" (burn petroleum) and eat it, too (use petroleum to make plastics, fibers and medicine).

FOOD FOR THOUGHT

You have learned the benefits which plastics have given mankind in this generation. You also learned that they can cause pollution and endanger health. Think about this: Are plastics the problem or is it the way we use them?

These points are worthy of discussion and we should see both sides of the problem of plastics and their place in the environment. Your interest may lead you to do investigations or community work or simply increase your awareness of the world in which you live.

REFERENCES

Australian Science Education Project. *Polymers.* State of Victoria, 1974.

Boord, C.E., Brode W. R., Bossect R. G. *Laboratory Outlines and Notebook for Organic Chemistry.* John Wiley and Sons, N. Y. 1955.

Fleck, Ronald, H. *Plastics-Scientific and Technological.* Chemical Publishing Co. Inc., N.Y. 1949.

Nuffield Chemistry. *Chemists in the World.* Longman Group Limited, 1979.

Pesigan, Luzonica. "Use of Plastics in the Food, Drug and Cosmetics Industries. *Industrial Philippines.* Aug. 1971.

Roth, Laszlo. *An Introduction to the Art of Packaging.* Prentice-Hall, Inc. N.J. 1981.

"Lab Tests on Plastic Bags Start." *Times Journal.* March 3, 1983.

"Public Cautioned on Plastics." *Bulletin Today,* March 16, 1983.